

## Chapter 1 Introduction

### 1-1. Purpose

*a. Role.* Hydrologic engineering plays a critical role in flood damage reduction planning. It provides technical information necessary to formulate alternative solutions to the flood damage problem and to evaluate those alternatives, thus permitting recommendation of a plan that best alleviates the problem while:

- (1) Yielding maximum net economic benefit;
- (2) Performing efficiently and effectively, even under extreme events; and
- (3) Protecting the Nation's environment.

This manual provides guidance for fulfilling this role.

*b. Scope.* Chapter 1 describes the planning problem, the flood damage reduction measures that may be included as solutions, the criteria for identifying the recommended solution, and the policies and procedures to be followed in the systematic search for the recommended solution. Subsequent chapters identify requirements for properly sizing, locating, operating, and maintaining the measures. Common requirements are described in Chapter 2; Chapter 3 describes the without-project conditions; and measure-specific requirements are defined in Chapters 4-9. Finally, Chapter 10 describes how the measures may be combined and the formulation and evaluation requirements for such plans. Appendices provide references to additional technical guidance and a summary of computer programs that may be appropriate for meeting the information needs for plan evaluation.

### 1-2. Applicability

This manual applies to HQUSACE elements, major subordinate commands (MSC), districts, laboratories, and field operating activities (FOA) having civil works responsibilities.

### 1-3. References

Required and related publications are listed in Appendix A.

### 1-4. Flood Damage Reduction Planning Problem

*a. Overview.* The Federal objective in flood damage reduction planning is to identify a plan that will reduce the flood damage problem and "... contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements (U.S. Water Resources Council (WRC) 1983 and ER 1105-2-100)." Typically, this is accomplished by formulating a set of likely solutions, evaluating each in terms of the national economic development and other standards, comparing the results, and identifying the recommended plan from among the set.

*b. Basis for comparison.* The measure of a flood damage reduction plan's contribution to national economic development (NED) is the net benefit of the plan. This is computed as the sum of location benefit, intensification benefit, and flood inundation-reduction benefit, less the total cost of implementing, operating, maintaining, repairing, replacing, and rehabilitating (OMRR&R) the plan. Location benefit is the increased net income of additional floodplain development due to a plan. Intensification benefit is the increased net income of existing floodplain activities. Inundation-reduction benefit is the plan-related reduction in physical economic damage, income loss, and emergency cost.

*c. Plan components.* A flood damage reduction plan includes one or more of the flood damage reduction measures listed in Table 1-1. The planning study determines which of these measures to include in the plan, where to locate the measures, what size to make the measures, and how to operate the measures. According to WRC guidelines, a study proceeds by formulating, evaluating, and comparing "various alternative plans ... in a systematic manner." That is, candidate combinations of measures, with various locations, sizes, and operating schemes, are proposed. Each alternative is evaluated with the criteria described previously. Of those formulated and evaluated, that alternative that reasonably yields the greatest NED contribution is referred to colloquially as the NED plan. Subsequent chapters in this manual provide guidance on selecting appropriate locations, sizes, and operation policies and describe how the inundation-reduction benefit due to each of the measures can be estimated.

**Table 1-1**  
**Flood Damage Reduction Measures<sup>1</sup>**

| Measures that reduce damage by reducing discharge | Measures that reduce damage by reducing stage | Measures that reduce damage by reducing existing damage susceptibility | Measures that reduce damage by reducing future damage susceptibility |
|---|---|--|--|
| Reservoir   | Channel improvement                           | Levee or floodwall   | Land-use and construction regulation                                 |
| Diversion   |   | Floodproofing  |  |
| Watershed management                              |   | Relocation   | Acquisition  |
|   |   | Flood warning and preparedness planning                                |  |

<sup>1</sup> In general, not a detailed specification.

*d. Standards.* In addition to yielding maximum NED contribution, the flood damage reduction plan recommended for implementation must

(1) Protect the environment, consistent with the National Environmental Protection Act (NEPA) and other laws, orders, and requirements; and

(2) Be complete, efficient, effective, and acceptable (U.S. Water Resources Council 1983), consistent with regulations, orders, and other legal requirements. (EP 1165-2-1 summarizes these.)

These limitations are referred to herein as the environmental-protection standard and the performance standard, respectively. Plans must be formulated to satisfy both standards, and analyses must be carried out to confirm that they do. A plan that satisfies both is declared feasible.

*e. Further guidance.* Further guidance on formulating plans and evaluating their feasibility is presented in Chapter 2. Subsequent chapters address the requirements for individual measures.

## 1-5. Corps Procedure for Finding a Solution to the Planning Problem

The Corps's approach to solving the flood damage reduction problem is through a sequential process that involves planning, design, construction, and operation. Planning or feasibility studies are performed in two phases, reconnaissance and feasibility, and conclude with recommending a plan for design and implementation.

*a. Reconnaissance.* In the first phase, the reconnaissance phase, alternative plans are formulated and evaluated in a preliminary manner. The goal is to determine if at least one plan exists that has positive net benefit, is likely to satisfy the environmental-protection and performance standards, and is acceptable to local interests. In this phase, the goal is to perform detailed hydrologic engineering and flood damage analyses for the existing without-project condition if possible (USACE 1988a). If a solution can be identified, and if a local sponsor is willing to share the cost, the search for the recommended plan continues to the second phase, the feasibility phase.

*b. Feasibility.* In the feasibility phase, the set of feasible alternatives is refined and the search narrowed. The plans are nominated with specific locations and sizes of measures and operating policies as illustrated by Table 1-2. Detailed hydrologic and hydraulic studies for all conditions are completed as necessary "... to establish channel capacities, structure configurations, levels of protection, interior flood-control requirements, residual or induced flooding, etc." (ER 1110-2-1150). Then, the economic objective function is evaluated, and satisfaction of the performance and environmental standards tested. Feasible solutions are retained, inferior solutions are abandoned, and the cycle continues. The NED and locally preferred plans are identified from the final array. The process concludes with a recommended plan for design and implementation.

*c. Design.* In the design or preconstruction engineering and design (PED) stage, necessary design documents (DM) and plans and specifications (P&S) for

**Table 1-2**  
**Plan Formulation/Evaluation for Feasibility-Phase Studies**

| Nominate Range<br>of Plans <sup>1</sup> | Iteratively Screen<br>and Refine Plans <sup>2</sup> | Develop Final Array<br>of Feasibility Plans <sup>3</sup> |
|---|---|--|
| Plan A                                  | Plan A  | Plan A   |
| Plan B                                  |   |  |
| Plan C                                  | Plan C  |  |
| Plan D                                  |   |  |
| Plan E                                  | Plan E  | Plan E <sup>4</sup>                                      |
| .                                       | .   |  |
| .                                       | .   | Plan G   |
| .                                       | .   |  |
| .                                       | .   | Plan I <sup>5</sup>                                      |
| Plan M                                  | Plan M  |  |

<sup>1</sup> Wide range of potential plans each consisting of one or more measures.

<sup>2</sup> Continuous screening and refining of plans with increasing detail.

<sup>3</sup> Each plan must have positive net benefits and meet specified performance, environmental, and other standards.

<sup>4</sup> Plan that maximizes NED.

<sup>5</sup> Locally preferred plan.

implementation of the proposed plan are prepared. These further refine the solution to the point that construction can begin. Engineering during construction permits further refinement of the proposed plan and allows for design of those elements of the plan not initially implemented or constructed. Likewise, the engineering during operations stage permits fine-tuning of OMRR&R decisions.

## 1-6. Role of Hydrologic Engineering

Hydrologic engineering is an element of civil engineering that "... analyze[s] water and its systems as it moves above, on, through, and beneath the surface of the earth" (EP 1110-2-10). Consequently, hydrologic engineering has "... a major participatory role in defining the flood hazard, locating and sizing flood damage reduction projects, and determining and assuring the functional and operational integrity of the project" (EP 1110-2-10). Hydrologic engineering provides hydrologic and hydraulic information, other engineering information, key components of the economic and ecological information, and input to the social-suitability and community well-being information.

## 1-7. Hydrologic Engineering Study Design

*a.* Proper administration of public funds requires that hydrologic engineering studies be well planned so the

analyses will provide the information required for proper decision making, be completed on time, and be within budget. To maximize the likelihood that this will be the case, one or more hydrologic engineering management plans (HEMP) will be developed for all flood damage reduction studies. EP 1110-2-9 provides guidance on HEMP preparation. A HEMP defines the hydrologic and hydraulic information required to evaluate the NED contribution and to ascertain satisfaction of the environmental-protection and performance standards. It also defines the methods to be used to provide the information, and identifies the institutions responsible for developing and/or employing the methods. From this detailed technical study plan, the firm time and cost estimates, which are included in the HEMP, can be developed.

*b.* An initial HEMP is prepared at the end of the reconnaissance phase; this defines procedures and estimates resources required for the feasibility phase. At the end of the feasibility phase, a HEMP is prepared to define procedures and estimate resources for the PED phase. At the beginning of the feasibility and PED phases, a HEMP also may be prepared to define in detail the technical analyses. The contents of a HEMP vary slightly depending on the study phase, but all contain the best estimate of the work to be performed, the methods for doing so, and the associated resources required.